CPC

Cellular Pump Control

ELECOMP Capstone Design Project 2018-2019

Sponsoring Company:

Taco Comfort Solutions™
1160 Cranston Street
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http://taco-hvac.com

Taco Comfort Solutions is continuing support of the Program they initiated last year:
https://web.uri.edu/elecomp-capstone/project-details-by-team/taco-comfort-solutions/

Company Overview:

Taco Comfort Solutions is a third generation, family-owned American manufacturer of high quality, high-efficiency heating, cooling, plumbing and irrigation products.

Headquartered in Cranston, RI, Taco is global in scope with manufacturing facilities in Rhode Island, Massachusetts, Arkansas, Ontario, Vietnam and Italy. Its skilled employees produce precision pumps, valves and controls, air-dirt separators, heat exchangers, tanks, domestic hot water recirculation systems, and web-based building management controls.

Since its founding, Taco has been dedicated to the success of its people and its customers, bringing products to market that save energy, enhance system longevity, and provide a superior level of safety and comfort to building occupants.

With nearly 100 years in the HVAC industry, Taco's knowledge and engineering expertise is passed along to professionals through the company's expansive factory training and online learning programs. That same depth of experience is applied every day at hundreds of job sites across the country, making Taco one of the most trusted names in controlling the flow of water.

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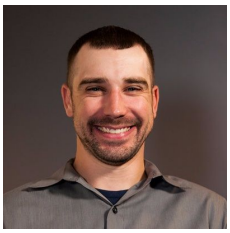

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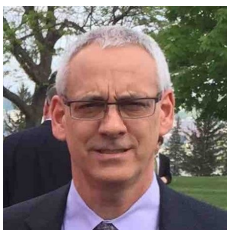


All Friday afternoon work will be completed at the Taco facilities in Cranston. Students interested in the project must have a means of transportation to and from the facility.

Project Motivation:

The Agricultural and Mining industries use pumps for irrigation and water removal respectively. These pumps are located some distance from the base of operations. The operators have to drive out to the fields or go down into the mines to turn on and off these pumps and sometimes just to monitor the pump to make sure it is running. Customers are looking for a remote web/phone application solution for controlling and monitoring this equipment.

Major accomplishments during 2017 /2018:

- Assembled prototype box and provided a safe means for the end user to connect sensors and VFDs
- Connected to the box over the internet.
- Sent and received data from the box.

More details: https://web.uri.edu/elecomp-capstone/project-details-by-team/taco-comfort-solutions/

Major accomplishments expected for 2018 /2019:

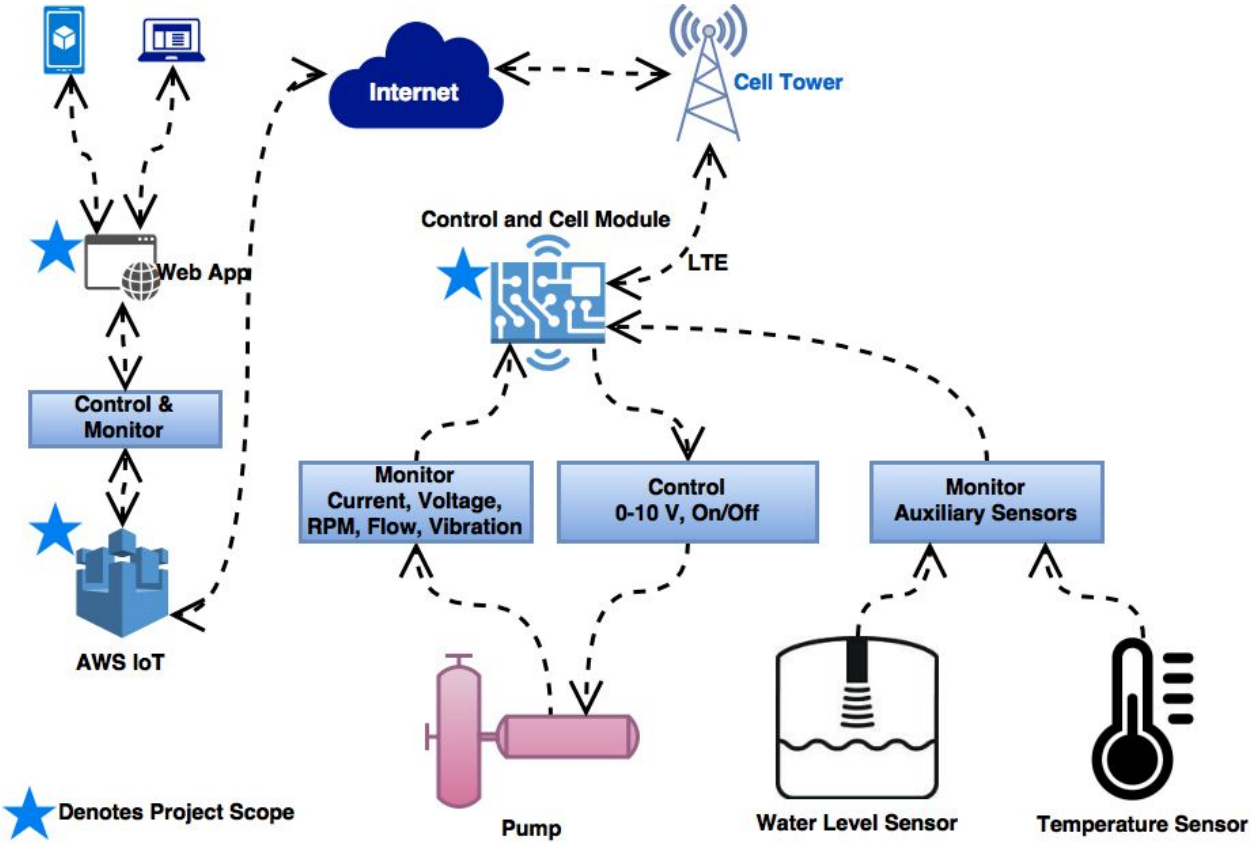
- Establish reliable mobile connection through the cell network
- Complete a full mobile application
- Finish wiring box for field ready application.

Anticipated Best Outcome:

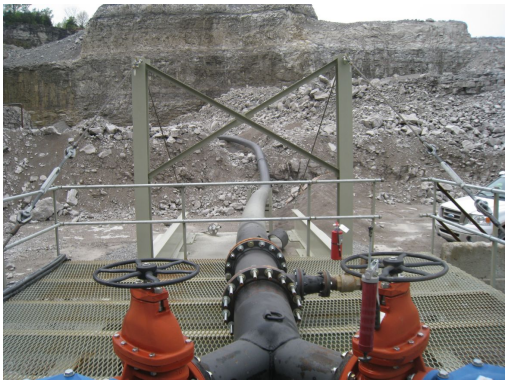
- Create software and hardware to control and monitor pumps via a web/mobile application.
- Develop a detailed product functional specification.
- PCB layout and adherence to FCC guidelines for RF products.
- BOM for all components and off-the-shelf devices.
- Develop software with guidance from Taco for format and protocols.
- Final report on goals achieved and next steps for extensions.
- Proof of concept design for beta testing.

Project Details:

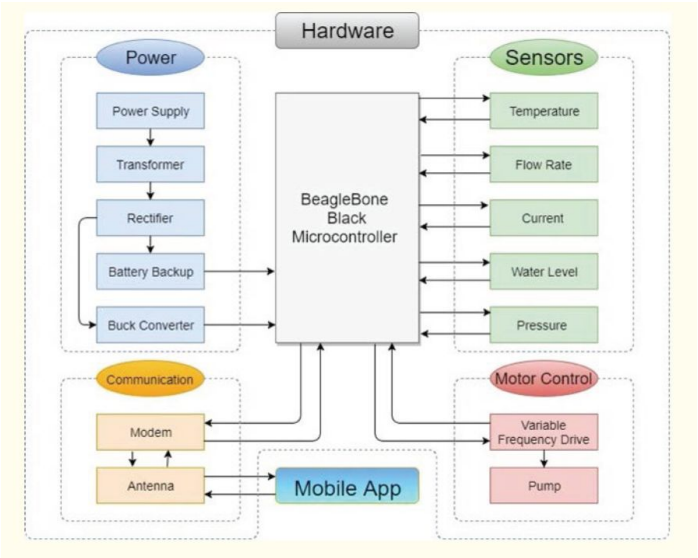
Block Diagram:

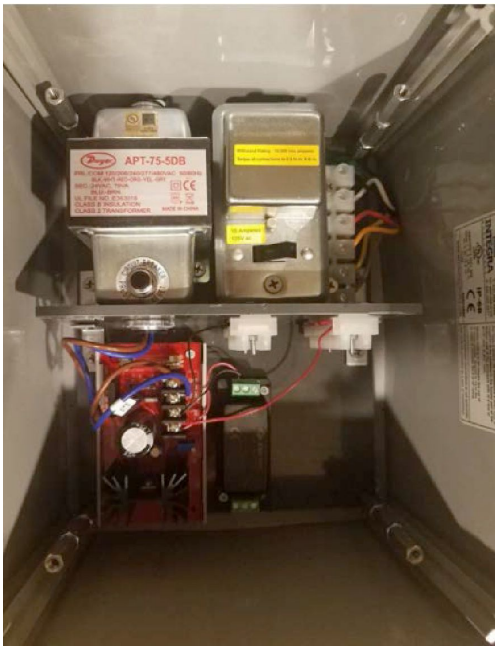


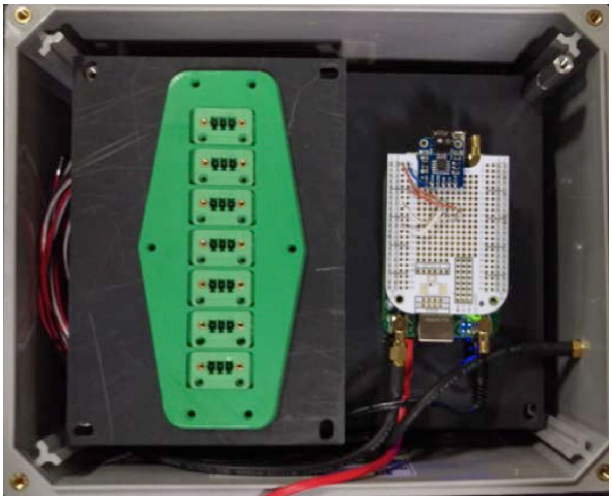
Pictures of Application Environment:



Pictures of prototype developed last year:







Hardware Tasks:

- Continue development of hardware interface between cellular module and pump control.
- Develop connection points from the box to the VFD (Variable Frequency Drive) to control the pump.
- Develop hardware connecting points to monitor the pump using sensors

Software Tasks:

- Continue development of software/ UI to control the pump.
- Develop Software to monitor the pump and sensors.
- Develop software to communicate with the web/mobile application
- Develop a basic web page and mobile application
- Develop IOT backend using Amazon Web Services

Functions:

- Pump Control:
    - ON/OFF control of pump through external relay.
    - 0-10 Volt control of pump via Variable Frequency Control
- Monitor Pump/ sensors via 0-10 Volt inputs:
- Possible inputs to monitor include:
    - Current
    - Voltage
    - RPM
    - Flow
    - Vibration
    - Water level
    - Temperature
    - Pressure
- Web App:
    - Pump control parameters
    - Pump monitor parameters
    - Motor fault handling, sensor fault handling
    - Motor run-time counters and data recording
    - Tie into weather monitoring
- Document theory of operation, command API
- Performance verification tasks include: tests that confirm signals and waveforms, capacity and performance, power and thermal management, and product functionality
- Product Validation tasks include: connect to Taco's test Pump and demonstrate to Taco engineers and product managers

Student Skills Needed

- Willingness to experiment and learn from mistakes
  - PCB design and layout experience beneficial *(Preference will be given to ELEs enrolled concurrently in the PCB Design Course, taught by Mike Smith)*
- C / C++ Programming experience an advantage
- Web/mobile app development
- Amazon Web Services experience an advantage, especially with AWS IoT

Composition of Team:

2 Computer Engineers and 2 Electrical Engineers.

Student Skills Required:

All team members share in developing product requirements, architecture and test development

Electrical Engineering (ELE) students (2) will split these tasks:

- Micro-Controller circuit development
- On/off output to turn pump on and off
- 0-10 Volt output to control pump speed
- 0-10 Volt input modules input
- PCB Layout

Computer Engineering (CPE) students (2) to split:

- Firmware pump control and monitoring
- Software cellar communication stack.
- Web/mobile application

Anticipated Best Outcome's Impact on Company's Business:

This Cellular Pump Control will be a big win for Taco. With the completion of the prototype, Taco will be able to expand upon the capstone design moving it into a manufacturable product for our customers.

Once Taco can offer this as an option to its agriculture and mine pumps customers we will be able to remotely control and monitor their equipment saving them time and money.

Broader Implications of the Best Outcome on the Company's Industry:

As this product gets out into the field and Taco adds the monitoring data to the cloud we will be able to start learning how product fail. With this information we can determine maintenance schedules and predict failures allowing the customer to perform the required scheduled maintenance or scheduled replace of the pump verses encountering unscheduled down time.